BULLETIN

OF THE

Society for the Promotion of Engineering Education

Vol. II LANCASTER, PA., JANUARY, 1912 No. 5

TABLE OF CONTENTS.

	PAGE.
Editorials	217
New Members	219
Applicants for Admission	221
Treasurer's Mid-year Statement	221
Committee on Statistics	222
Letter to the Editor	222
Faculty Work for Alumni, by Prof. Geo. R. Chatburn	224
Simple and Instructive Experiments in Hydraulics, by Director Robert Fletcher	226
Recent Conventions of Road Builders, by Prof. A. H. Blanchard	228
The National Mine Safety Demonstration, by Prof. F. W. Sperr	231
Sanitary Engineering at Harvard, by Prof. Geo. C. Whipple	242
The Lack of Relation between Mathematical and Engineering Talent, by President W. M. Riggs	248
The New Mason Laboratory at Yale, by Prof. L. P. Breckenridge	252
Scientific Shop Management, by Prof. Hugo Diemer	257
College News	270

EDITORIALS.

The Bulletin Program for 1912.—With the December issue the publication of the Pittsburgh Convention papers was completed. The papers have been in convenient form for study so that written contributions to the discussion could be made readily. Numerous contributions have been received and will appear in due course in the *Proceedings*. For the next few months there will be space for contributed papers and such are invited. The present issue contains several such papers. In

March will appear the first of the 1912 Convention papers, one by Professors W. S. Franklin and Barry MacNutt, on the Teaching of Physics to Engineering Students. There will also be preliminary announcements regarding the Convention which will probably be held in Boston during the week beginning June 23. The American Institute of Electrical Engineers will hold a convention in Boston from June 25 to 28 inclusive.

The Proceedings.—Volume 19 of the *Proceedings* is now nearly complete. Publication has been delayed to permit members and others to send in contributions to the discussion of the Pittsburgh papers and reports. There is still time for this if contributions are sent immediately. Proof of all articles will be sent to the authors giving ample opportunity for revision. Since the papers have been available in preliminary form in the BULLETIN the written contributions have been increasing in number and value. This year they are exceptionally good.

The Year-book.—The next issue of the BULLETIN will contain the membership list, statistical tables, and the Constitution and By-laws. The list of members will be considerably longer than that in the last year-book, but it is not as long as might have been expected from the number of members on the roll at the time of the annual meeting. The list will contain the names of members in good standing only. As last year, the year-book will be bound in tough cartridge-paper covers. These have been found to stand hard usage, which the book is apt to get as it is a convenient directory of live teachers and progressive engineers. A very large edition of the year-book will be printed as last year's edition was almost immediately exhausted. Copies will be sent, on the request of members, to persons who might desire to apply for membership. Copies will be sold to non-members at fifty cents each and extra copies will be furnished to members at one-half this amount.

The Society's Finances.—The Treasurer makes an interesting statement of his work in this issue. As a result of the

slight increase in dues the income has become sufficient to cover running expenses including those incident to the publication of the BULLETIN. There is a substantial balance stored against the time when the bill for printing the *Proceedings* will fall due. The Treasurer has started a separate account for the life membership fees which form the nucleus of a permanent fund which should, in time, become a substantial fund. This fund will, presumably, be invested in safe bonds in due time. The accounts of the Society are now kept in double-entry and are in perfect order in modern loose-leaf ledgers. The new system went into operation on January first.

Our New Members.—The Society is to be congratulated again upon the appeal which it makes to engineers of standing. These men evidently desire to assist in the work of technical education in a practical way and they are always ready to contribute to the discussion of papers or lend a hand in other lines. It has been recently pointed out by a prominent engineer that it is a duty for successful men to unite with the Society and to help along its work. In addition to the engineers there is a steady accession of instructors and occasionally a department head or dean is heard from. The Membership Committee requests the help of every loyal member in compiling a new list of possible members. Suggestions sent to the Secretary will be promptly acted upon and printed matter describing the work of the Society will be sent out.

NEW MEMBERS.

The Council has acted favorably upon the following applications as well as those of Messrs. Boyle, Freeman and Watt, listed on p. 157 of the December BULLETIN.

ASHE, S. W., Engineer and Educator, General Electric Co., Harrison, N. J. 1911

CHAMBERS, S. D., Instructor in Mathematics, University of Maine, Orono, Me. 1911

CURTISS, CHAS. D., Instructor in Civil Engineering, Michigan Agricultural College, East Lansing, Mich. 1911

DEEDS, EDW. A., Vice-President, National Cash Register Co., Dayton, O. 1911
DIETZ, J. W., Manager, Educational Department, Western Electric Co., New York, N. Y. 1911
DUNMORE, G. B., Assistant Professor of Engineering, Whitman College, Walla Walla, Wash. 1911
EINSTEIN, A. C., General Manager, Union Electric Light and Power Co., St. Louis, Mo. 1911
FISHER, GEO. H., Manager, International Correspondence Schools, Scranton, Pa. 1911
FITZGERALD, DESMOND, Consulting Engineer, 410 Washington St., Brookline, Mass. 1911
GREINER, J. E., Consulting Engineer, Fidelity Bldg., Baltimore, Md. 1911
GREMPLE, CHAS. W., Instructor in Mechanical Drawing, University of Pennsylvania, Philadelphia, Pa. 1911
HABERMEYER, G. C., Associate in Municipal and Sanitary Engineering, University of Illinois, Urbana, Ill. 1911
HAMILTON, GEO. A., 532 Morris Ave., Elizabeth, N. J. 1911
HAWLEY, J. B., Consulting Engineer, Hoxie Bldg., Ft. Worth, Tex. 1911
HENRY, P. W., Consulting Engineer, 506–25 Broad St., New York City 1911
HOAGLAND, I. G., Editor and Manager, Insurance Engineering, 120 Liberty St., New York City 1911
HOLLISTER, V. L., Adjunct Professor of Electrical Engineering, University of Nebraska, Lincoln, Nebr. 1911
LIEB, J. W., JR., Third Vice-President, The New York Edison Co., 55 Duane St., New York, N. Y. 1911
MCALLISTER, A. S., Associate Editor of Electrical World and Lecturer in Electrical Engineering, Pennsylvania State College, 239 West 39th St., New York, N. Y. 1911
MCMILLIN, EMERSON, Chairman of Board of Directors of American Light and Traction Co. and President of many Companies, New York, N. Y. 1911
SMITH, T. GUILFORD, 203 Elliott Square, Buffalo, N. Y. 1911
SPRAGUE, FRANK J., Consulting Engineer, 116 Riverside Drive, New York, N. Y. 1911
STONE, C. W., Consulting Engineer, General Electric Co., Schenectady, N. Y. 1911
TOWNE, LOCKWOOD J., Instructor in Civil Engineering, University of Illinois, Urbana, Ill. 1911
WALLIS, R. S., Instructor in Civil Engineering, Iowa State College, Ames, Ia. 1911

APPLICANTS FOR ADMISSION.

HOBART, H. M., Consulting Engineer, General Electric Co., Schenectady, N. Y. 1912
MARR, ROBT. A., Dean of the Engineering Department, Viriginia Polytechnic Institute, Blacksburg, Va. 1912
PORTER, J. F., President of the Tri-City Railway and Light Co., Davenport, Iowa 1912
SCHILDHAUER, EDW., Engineer with the Isthmian Canal Commission, Culebra, Canal Zone 1912
SCHUCHARDT, R. F., Electrical Engineer, Commonwealth Edison Co., Chicago, Ill. 1912
THOMSON, R. D., Instructor of Electrical Engineering, University of Vermont, Burlington, Vt. 1912
TURLEY, O. J., Civil and Irrigation Engineer, Turley Ditch Co., Inc., Turley, San Juan Co., New Mexico 1912
UX, RUSSELL R., Designer of Model Steam Engines and Locomotives, 740 Hellertown Ave., Allentown, Pa. 1912
WOOSTER, L. F., Instructor in Electrical Engineering, Oregon State College, Corvallis, Ore. 1912
ZELLER, J. W., Instructor in Mechanical Engineering, University of Florida, Gainesville, Fla. 1912

TREASURER'S MID-YEAR STATEMENT.

The following brief approximate statement covers the period from the Pittsburgh meeting to and including December 16, 1911.

Received to date on current dues	$2,388.00	
Received to date for back dues	172.10	
Received to date for life membership dues	50.00	
Received to date from other sources	775.75	
Total receipts		$3,385.85
Paid to date on expenses of Pittsburgh Meeting	$ 222.00	
Paid to date for expenses of Treasurer and Secretary	1,046.89	
Paid to date for printing	1,086.47	
Refunded to Throop Polytechnic Institute	2.00	
Total expenditures		$2,357.36
Due for current dues	$1,580.00	
Due for back dues	177.50	
Due from non-members	119.50	
Due from members, other than for dues	3.01	
Total amount due the Society		$1,880.01
Cash on hand at beginning of year, July 1, 1911		$1,005.46

Cash on hand at date, December 16, 1911:

Permanent fund	$ 250.00	
Current expense fund	1,783.95	
Total amount on hand December 16, 1911		$2,033.95

W. O. WILEY,
Treasurer.

THE COMMITTEE ON STATISTICS.

Professor H. W. Tyler, of the Massachusetts Institute of Technology, who has been appointed chairman of the standing Committee on Statistics, invites suggestions and expressions of opinion from members of the Society in regard to the lines of work which the Committee may follow to best advantage. It is his opinion that it is better to collect too few statistics than too many, and that statistical information is often of very little value in consequence of differences of conditions which are not capable of statistical expression. On the other hand, a limited amount of statistical work, carefully planned, executed and digested, is certainly valuable. The Committee will be particularly interested to know whether statistics of engineering education, as now tabulated in the annual report of the Commissioner of Education, are considered by members of the Society to be in the best form practicable, and in what respects, if any, they need to be modified or supplemented.

President Raymond has appointed on the Committee on Statistics Mr. Walter B. Snow, Publicity Engineer, Boston, Mass., and Professor L. J. Johnson, of Harvard University.

LETTER TO THE EDITOR.

MINNEAPOLIS, MINN.

SECRETARY S. P. E. E.,

Dear Sir: A recent praiseworthy innovation in the Department of Rhetoric, in the College of Engineering of the University of Minnesota is the adoption of "Addresses to Engineering Students," published by Waddell and Harrington.

This most excellent work is used by the freshman class for collateral reading, study and review. The charming style in which it is written, the breadth of view it takes and the high ideals it so forcefully presents, both of the character of the engineer and of his mission and work, must prove of incalculable benefit to the faithful student of its contents. It is impossible for either undergraduate or graduate students to thus study it and not have a loftier ideal of the profession and what it requires, and a greater inspiration to do better work. Messrs. Waddell and Harrington deserve the hearty thanks of all students of engineering for their interest and generosity in furnishing this volume for the bare cost of publication.

Sincerely yours,

ARTHUR E. HAYNES.

FACULTY WORK FOR THE BENEFIT OF ALUMNI.

BY PROFESSOR GEO. R. CHATBURN.

The College of Engineering of the University of Nebraska is inaugurating a record and employment bureau. File No. 1 is a record book in the form of a loose-leaf ledger with a leaf for each graduate of the College of Engineering, each former student of the College of Engineering who is engaged in engineering pursuits, and each graduate or former student of other colleges of the University who is engaged in engineering pursuits. On this leaf are recorded all relevant data concerning the person to whom they relate.—File No. 2 is a catalog, made up of five by eight inch cards, covering as far as it goes the same names and data as are set forth in file No. 1. The difference is that file No. 2 is supposed to include only the names of those who are actively engaged in engineering or related occupations and who may be considered representative of the engineering training obtained at the University.—File No. 3 is simply a letter file with a folder for the correspondence relating to each man included in the record.—Files Nos. 4A and 4B are used in connection with the employment feature of the bureau. No. 4A is made up of three and three quarter by eight inch cards which contain on one side what is practically an application for employment. When the bureau has opportunity to fill a place requiring the qualifications of any certain man the reverse side of his application card is filled out with data concerning the position and the card is sent to the applicant, with a blank card of the same form enclosed. The blank card is to be filled out by the applicant and returned to the bureau in case the applicant is not engaged for the position of which he has been notified. No. 4B is a card of the same size as 4A. Only one side is used, this being filled out with data concerning engineering vacancies of which the bureau learns. Nos. 4A and 4B are filed together, a black metal clip on the

card indicating an application for a position and a red metal clip on the card indicating a position open. The position of the clip on the card indicates whether it relates to civil, electrical, mechanical or special engineering.

It is proposed to make the record complete for men graduating from this time on, and as nearly so as practicable for all others. An attempt will be made to follow up men indefinitely with the record. The bureau will interest itself with regard to the employment of the men so long as they merit such interest, or until they have attained such commanding positions that they may be considered independent of the assistance which the bureau may be prepared to offer.—A feature of the record is the faculty estimate of each man in respect to qualifications which may affect his success in engineering. Each card of file No. 2 will carry a photograph of the man to whom it relates.—The record will be kept up-to-date chiefly through correspondence. It is proposed to prepare at frequent intervals a news letter concerning the University, the College, and the graduates and former students. This news letter will be made as interesting as possible and will be enclosed with each request for information and data will continue to be sent to all who respond to the accompanying request.—"There are practically no original features in the system as formulated," is the modest statement of O. V. P. Stout, head professor of civil engineering, who is in charge of the bureau. To him alone belongs the credit of collecting and establishing upon a workable basis this combination of what were considered the best available features of the systems in use in other institutions.

SIMPLE AND INSTRUCTIVE EXPERIMENTS IN HYDRAULICS.

BY DIRECTOR ROBERT FLETCHER.

It may not have occurred to some members of the Society interested in giving instruction in hydraulics that the hydraulic ram and syphons furnish quite instructive examples and illustrations of important principles at small expense. A Gould ram of almost any desirable size costs but a few dollars. A simple tank placed so as to give from eight to ten feet of head, with thirty or forty feet of drive pipe, are not very expensive adjuncts; and a three quarter inch delivery pipe can be rigged up into almost any position to discharge into a tank in the attic or by a return pipe back into the supply tank. By arranging the delivery pipe in a series of sections hinged by means of reversed quarter bends and nipples the summit can be gradually raised from a low to a high position giving opportunity to study the action of the ram under different heads and through a constant length, and requiring but two or three minutes to change the head. The number of variables in the operation being so many, that is: length and size of drive pipe, length of the stroke of the ram, head against which it operates, size of the delivery pipe, etc., the class obtains an opportunity to work out the varying conditions of efficiency in a very satisfactory way. The cost of a few wrenches, a pipe cutter and a set of pipe threading tools is small, and with these appliances the students very quickly learn to do their own pipe fitting, and thus gain all the advantage of planning and arranging their apparatus.

As to syphons, a very simple and inexpensive arrangement is the following: Having a water tank of good size, say 3 ft. by 4 ft. by 3 ft. deep, an up-take pipe may be passed through a plank (resting on the top) so as to project into the water. A longer down-take pipe may be fastened to the same plank

so as to terminate outside at the desired level below the water surface within. Then a U-shaped section of $\frac{3}{4}$-inch pipe, or larger if desired, may be hinged to the fixed pipes just above the plank by reversed quarter bends and nipples, and held at any angle with the horizontal by suitable lifting rope. If the length of this syphon section is from 31 to 33 feet the possibility of operation under extreme conditions may be tested thus: Let the syphon lie first in a horizontal position. If water under pressure is available the syphon can be filled in a few seconds by use of a small hose pipe and nozzle. When the flow through the syphon has become established, and determined by weighing the quantity of water which passes in a given time, the summit of the syphon may be raised successively to 5, 10, 15 feet etc., until finally in the upright position it will be at 32 feet or more above the water surface. Observations of discharge, as in the case of the ram, will be made by the usual weighing and comparing with the theoretical discharge to determine the effects of friction, etc.

Other observations with the syphon will occur to the experimenter and will require but little change of conditions in order to make them. For instance, the effect of making a larger up-take and contracting to a smaller down-take near the summit by any convenient means as by reducing bends or straight reducers, etc.

These remarks are merely for suggestions; as "a word to the wise is sufficient" enough has been said for the present.

RECENT CONVENTIONS OF ROAD BUILDERS.*

BY PROFESSOR ARTHUR H. BLANCHARD.

The American Road Builders' Association held its eighth annual convention on November 14 to 17, inclusive, in Rochester, N. Y., the attendance being over 1,450. There were nine sessions in all and a specific subject was allotted to each, thus giving ample time for a thorough discussion on each topic. The first session was devoted to addresses of a non-technical nature. In the second session the main topic under consideration was "Highway Administration." The leading address was by John A. Bensel, State Engineer and Surveyor of New York, and a valuable discussion was contributed by George W. Cooley, State Engineer of Minnesota. The subject before the third session, "Adaptability of Roads and Pavements to Local Conditions," was presented in a paper by Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment of New York City. The leading discussion was by W. A. McLean, Provincial Engineer of the Province of Ontario, Canada, who was followed by delegates from the floor. Major W. W. Crosby, Chief Engineer of the Maryland State Roads Commission, was the principal speaker in the fourth session, his subject being "Problems of Construction." Papers were also read upon the same subject by R. A. Meeker, State Supervisor of Roads of New Jersey, and Charles Ross, Street Commissioner of Newton, Mass. The fifth session was devoted to "Contractors' Criticisms of Road Contracts," which was presented in a paper by C. A. Crane, Secretary of the General Contractors' Association, and thoroughly discussed. In the sixth session a further discussion was held on the same subject. In the evening, session seven,

* This article was prepared at the request of the Editor in view of the rapid expansion of the subject of highway engineering and the corresponding increasing attention being given to it by the technical schools.

illustrated lectures were given as follows: "European Roads," by Arthur H. Blanchard, Professor of Highway Engineering, Columbia University, New York City; "American Roads," by Paul D. Sargent, Assistant Director of the Office of Public Roads; and "New York Roads," by Fred. Buck, Assistant Deputy, Bureau of Town Highways, New York State Highway Department. In the eighth session, on November 17, the main address was on "Maintenance of Roads and Pavements," by James Owen, County Engineer of Essex County, New Jersey. A. W. Dean, Chief Engineer of the Massachusetts Highway Commission, and J. C. Travilla, Street Commissioner of St. Louis, Mo., led the discussion which was afterwards participated in by several other prominent engineers. A most successful and complete exhibition of road machinery and materials was held in conjunction with the convention and proved of great educational value.

The first convention of the American Association for Highway Improvement was held in Richmond, Va., on November 20, 21, 22 and 23, the attendance being about 800. The four days were known as "National Day," "Highway Engineers' and Contractors' Day," "Road Users' Day" and "Association Day" respectively. Addresses were delivered by city, state and national officials and officials of various associations interested in highway improvement. The first day was devoted to the general questions of road improvement and the speakers emphasized many points relative to this subject, the essential ones being the extension of national aid, the advantage of convict labor for road work, and the importance of proper maintenance of all highways. General T. Coleman du Pont, of Delaware, described the plans and stated the purpose for the $2,000,000 road which he is to have built across the State of Delaware. Also the advisability of training for highway work was especially emphasized. On the second day, at the morning session, the following engineers presented papers: W. A. McLean, Provincial Engineer of Highways of Ontario, Canada, on "Gravel Roads"; Captain P. St. J. Wilson, State Highway Commissioner of Virginia, on "Sand-Clay and

Earth Roads"; Major W. W. Crosby, Chief Engineer of the Maryland State Roads Commission, on "Bituminous Roads"; Arthur H. Blanchard, Professor of Highway Engineering at Columbia University, New York City, on "Road Costs and Maintenance"; and W. P. Blair, Secretary of the National Paving Brick Manufacturers' Association, on "Brick Pavements." In the afternoon session Onward Bates, Past-President of the American Society of Civil Engineers, spoke on the subject of "Contracts and Contracting"; Captain D. L. Hugh, President of the United Engineering and Contracting Company of New York City, followed with an address on the same subject, and Frank Terrace, of Washington, spoke relative to "Convict Labor." On the third day, the subjects considered were of a nature especially interesting to road users, such as automobile laws, traffic regulation, and automobile industry as related to good roads movements. A committee presented resolutions embodying the following recommendations: To endeavor to establish the principle of national aid; to cause the subject of maintenance to be duly considered by road authorities and to seek for the providing of proper supervision by state legislation; to advise the employment of only experienced highway engineers for construction and maintenance work; and to recommend the enactment of laws providing convict labor for road improvement. On the last day the addresses related to convict labor; the safety of highways, especially at railroad grade crossings; association work; a progress report of the work of the Lincoln Memorial Highway Association; and the good roads work of the American Automobile Association.

THE NATIONAL MINE SAFETY DEMONSTRATION.

BY F. W. SPERR,

Professor of Mining and Civil Engineering, Michigan College of Mines.

An important phase of engineering education was presented in Pittsburgh, Pennsylvania, on October 30 and 31. This was the National Mine Safety Demonstration given by the United States Bureau of Mines under the Department of the Interior. It was prepared and conducted by Dr. Joseph A. Holmes, the director of the Bureau. It had the presence and encouragement of the President of the United States, of the Secretary of the Interior, and of the Governor of Pennsylvania. That it was a mine safety demonstration is merely incidental. That it was given in a coal mining region and employed coal mining subjects, was merely convenient. That it made use of coal mine explosions to illustrate mining accidents, was expedient. Fundamentally it was an industrial safety demonstration in which all industrial engineers might well be interested. It was given in a great industrial center comprising many hazardous professions. It made use of mine explosions because such accidents attract and hold the attention, not only of an audience, but of the general public as well. In fact other accidents in mining and in many surface enterprises, cause more injuries and deaths, but they are less spectacular.

The first day's program was wholly given by the officials and employees of the Bureau of Mines. The second day's demonstrations were given under the auspices of the United States Bureau of Mines, the American National Red Cross, and the Pittsburgh Coal Operators' Association.

The forenoon of the first day was devoted to an inspection of the work of the Bureau of Mines in the laboratories and experimental plants at the Arsenal Grounds. From

8:30 to 10 A.M. was occupied by an inspection of ten different operations in the chemical and physical laboratories: (1) Measurement of high temperatures; calibration of physical apparatus and instruments; determination of thermal conductivity at high temperatures; investigation of the explosibility of mine gases; (2) determination of heating values of solid and liquid fuels in the bomb calorimeter; (3) operation of hand fired return tubular boiler arranged for smoke prevention; (4) fuel laboratory, proximate and ultimate analysis of coal, lignite, peat and coke, analysis of mine and boiler water, coal ash and slag; (5) petroleum laboratory, inspection and analysis of fuel oils, petroleum investigations; (6) research on the chemical constitution of coal; investigation of the relative explosibility of coal dusts; (7) gas laboratory, investigation of mine air and natural gas; gas analysis apparatus; examination of natural gas for gasoline manufacture; physiological effects of noxious mine gases; (8) investigations of destructive distillation of coals; weathering and spontaneous combustion; occluded gases in coal; (9) photographic laboratory; (10) explosives laboratory, analysis of black powder, dynamite, and permissible explosives, testing the stability of explosives;; strength of detonators; danger of exudation of nitroglycerine explosives. There is also a library room and three different rooms are devoted to mining engineering investigations.

No doubt a great deal can and will be accomplished by the Bureau of Mines in its investigations of mining methods. The mine foreman should have the benefit of expert assistance as the result of a wide range of observation and research; even as the farmer now has the benefit of such assistance from the Department of Agriculture. It may be thought that this can not be done for mining as it can be done for farming; but many of us can well remember when it was considered impossible to do it for farming.

At 10 A.M. an address of welcome to the visiting guests was given by Director Holmes as the eleventh event of the day. At the close of his address, he introduced Secretary

of the Interior Walter L. Fisher. Secretary Fisher commended the mine operators, experts, engineers, members of rescue teams, and miners for the interest manifested by them in the first national mine safety demonstration. He considered the importance of the mining industry second only to that of the agricultural, and promised the support of the government to the welfare of its interests. He urged cooperation between the Bureau of Mines, the operators' association and the miners in providing additional safeguards for the miners, and in joining mutually to increase efficiency for the conservation of life and mineral resources.

10 A. M. to 12 A. M. Operations (12) to (20) were continuously running and could be witnessed at intervals between the scheduled operations (11) and (20) to (24). They are conducted for the purpose of devising methods for the conservation either of human life or mineral resources.

(12) Breaking lighted incandescent lamps in an explosive mixture of gas and air; illustrating their relative safety. (13) Foundry cupola showing method of taking gas samples and temperatures in the various zones of the coke bed, for the purpose of studying the fundamentals of the process, with a view to possible improvement. (14) Gas producer burning fuel at high temperature and capacity, removing accumulation of ash and clinker by tapping off the liquid slag periodically. (15) Smokeless combustion of low-grade, high volatile fuel in boiler furnaces using mechanical stokers. (16) A long combustion chamber used to investigate combustion in boiler furnaces, and the conditions necessary for complete combustion of coals of various composition, when rate of firing and air supplied through grate and above fuel bed varies. (17) Single and double gauze safety lamps in a current of air of a known velocity containing eight per cent. of methane and ethane; a demonstration of their relative safety. (18) Men wearing various types of breathing apparatus training in noxious atmosphere. (19) Exhibition of apparatus for the physical testing of explosives: Ballistic pendulum, pressure gauge, calorimeter; flame testing apparatus; rate of detonation apparatus; large and small impact machines; cone and pendulum friction device; Trauzl and small lead blocks. (20) Lignite and coal briquetting plant; making briquettes from California lignite.

10:30 A. M. (21) Gas and dust explosion, Gallery No. 1. A "permissible explosive" equivalent in deflective force to one half pound of forty per cent. nitro-glycerine dynamite tamped with one pound of dry fire clay, is fired into a mixture of gas and air containing seven per cent. of

methane and ethane. At Forbes Field, October 31, events (21) and (23) were repeated in the presence of coal dust instead of mine gas.

10:45 A. M. (22) Ignition of coal dust by means of laboratory coal dust ignition apparatus.

11:00 A. M. (23) Gas and dust explosion, Gallery No. 1. Black blasting powder, FFF, equivalent in deflective force to one half pound of forty per cent. nitro-glycerine dynamite tamped with two pounds of dry fire clay, fired into a mixture of gas and air containing seven per cent. of methane and ethane.

11:30 A. M. (24) Gas and dust gallery No. 2. Electric mine motor, operating in an explosive mixture of gas and air, had explosion-proof protective devices removed, causing an explosion.

The afternoon of the first day was given to the

Official Opening of the Experimental Mine of the Bureau of Mines.

The Experimental Mine of the Bureau of Mines is situated near Bruceton, Pa., on the Wheeling Branch of the Baltimore & Ohio Railroad and is in the Pittsburgh seam, which at this point outcrops on the side of a hill about one hundred feet above the railroad.

The mine was opened primarily in order to study the phenomena of dust and gas explosions and to test various methods of preventing and checking explosions in progress under actual mine conditions, which requires repeated explosions under varied conditions.

Plan.—The arrangement of the part of the mine used for the explosion on October 30 was as follows:

An outside steel gallery of one half inch boiler plate, 102 feet long and 6 feet 4 inches in diameter, is connected by a twenty-foot movable steel section and a twenty-foot concrete explosion-door section to a slant entry. This entry intersects the east entry or aircourse 192 feet from the end of the explosion door section. The entire slant entry ,70 feet of the aircourse and 169 feet of the main entry are lined with reinforced concrete. Heavily reinforced concrete portals are built at the mouths of the gallery slant and main entry.

One surface and four underground instrument chambers have now been constructed. The wires from the instruments in these stations pass through pipes behind the concrete lining to recording instruments in the observatory. Pressure variations at the stations and velocity readings are taken by these instruments in conjunction with those at the observatory. Gas samples are taken by special devices at the instrument station.

The mine is prepared for the explosions by placing coal dust on the

floor of the steel gallery and on wooden shelves along the sides of the entries, which is exploded by firing a charge of black blasting powder (representing a blown-out shot) into the steel gallery.

Afterwards the entry doors are closed and men in oxygen helmets enter the mine through a slide door in the main entry door, to take gas samples, extinguish incipient fires and inspect the condition of the roof. Later, when conditions are safe, the fan is started and the mine cleared of afterdamp. Should it be necessary, timbermen then enter the mine to remove loose pieces of hanging rock and place temporary timbers. Afterwards records are made of the effects of the explosion.

(25) A party of about 1,500 arrived at Bruceton by special train at 3 P. M. After passing through the mine on a trip of inspection, the visitors climbed up the hillside beyond the danger line and waited for the explosion. The first two trials missed on account of defects in the wires from the electric battery to the charge of powder. It was now growing dark, and many were willing to take Dr Holmes' word for it and call the event off, rather than prolong the dangerous work into the night. These betook themselves to the depot where the special train was waiting. Many others, however, called loudly for the performance to go on; and Dr. Holmes with indomitable perseverance and inexhaustible resourcefulness, succeeded in having the wires made perfect; and the explosion burst forth with a deafening roar and with a destructiveness to property, if not to life, which gave many of those present a better idea of the real meaning of the accounts of mine explosions about which they had read. There was the darkness, the drizzling rain, and the mud, to help make the scene realistic; but the audience was spared the "agonizing cries of the wounded and the heart-breaking wails and moans of the bereaved ones standing around the pit mouth."

Everyone was convinced that coal dust may cause a disastrous mine explosion; but it was now too late in the day to permit the visitors to inspect the mine to see the damage done. The party returned to Pittsburgh in time to attend the reception at the Fort Pitt Hotel—the most enjoyable event of the occasion.

The closing features of the reception were speeches by

Secretary Fisher, by President John Laing, of the Association of State Mine Inspectors, and by Director Holmes introducing the other speakers. Thus ended the first day of the First National Mine Safety Demonstration, at 12 o'clock, midnight.

On the morning of the second day at 9 o'clock, 10,000 people gathered on Forbes Field to witness the demonstrations of first aid to the injured, of mine rescue work, and of one of the minor classes of mine accidents. It may not be generally known that the explosion of mine gas or coal dust belongs to the minor classes of mine accidents.

It would seem as though it must have been known for centuries that a man's chances for recovery from an accident depended much upon how quickly he received attention after the injury and upon the kind of aid he then received. Yet the idea of training the men employed in hazardous occupations, the men who are there first when an accident occurs, in first aid to the injured, took on practical form only as far back as 1880. It was then that the St. John's Ambulance Association was organized in England. Then came the St. Andrew's Ambulance Association in Scotland, the Sameritter Verein in Germany and similar organizations in France, Belgium and Austria.

Membership in these European first-aid organizations is permitted only after long and careful training. The work has been so dignified that the attainment of membership is considered a great honor.

The first serious consideration of first aid to the injured in the United States was given by some of the railroad companies as late as 1897; packets and books of instructions were then furnished by these companies to some of their men. In 1899 the work was started in the anthracite coal fields, where it is now an essential feature in the organization of the mining forces.

In 1910 the American Red Cross organized a separate first aid department, and in the same year the Young Men's Christian Association made first aid a part of their educa-

tional work. At the present time in all the mining states the progressive mining companies have established the work of first aid to the injured among their men. The work has gone much further than its first beginnings of furnishing packets and books of instructions. The men are now systematically taught and drilled on imaginary injuries to each other. Competing teams are organized and prizes are awarded to the winners in contests that are periodically held. All too often, of course, the teams have practice in cases of real accidents.

Forty prize winning first aid teams from all over the United States participated in the demonstration of first aid to the injured. The work of these teams exhibited the high degree of efficiency to be attained by such training as they had received. President Taft in his address on the occasion manifested great pleasure in the work and called the men "self-made surgeons."

This work may be expected to spread and become firmly established all over the world.

The *Coal Age* of October 28 gives an interesting account of the first aid movement in the anthracite coal region:

> During the past six weeks the First Aid Corps of the mines which have organized these helpful institutions have been holding contests throughout the anthracite regions, and remarkably interesting and instructive these have been. The contests have now become annual events in most mining localities in northeastern Pennsylvania. The men who are engaged in these contests take a personal pride in the efficiency of the corps to which they belong.
>
> During the time that these contests have taken place, exhibitions have been given in various centers, generally in the vicinity of Scranton, Wilkes-Barre, Pottsville, Shamokin, Mahanoy City, Carbondale and occasionally in the neighborhood of mining settlements. The contests are not competitions in the conventional sense. Although medals are sometimes distributed among the winners of a contest, the men are for the most part indifferent to the honor conferred by these, and to their intrinsic value. Indeed they seem almost to deprecate their institution as awards.
>
> About two hundred corps have taken part in these contests during the time that they have been in progress. It is no exaggeration to say that

first aid to the injured, scientifically administered, is now as much a part of the machinery of the anthracite mines as any other department of the executive administration of the colliery. Each mine with a first-aid corps has its dispensary at the foot of the shaft, fully supplied with such appliances as are immediately needed in any ordinary emergency.

While distributing medals at one of these contests recently an old clergyman declared, with considerable truth, in the presence of the men and officials of the two collieries between which the contest was held, that within his own recollection, some 35 or 40 years ago, the lives of the mules in the anthracite mines were much more carefully guarded than those of the miners, it being accepted as a managerial axiom that the loss of a mule was estimated at $3 a day for the period of its working life, while the life of a miner was of no economic value, no material difference in the profit and loss account of the working of the mine resulting by his accidental death.

From 9 A. M. to 10:30 A. M. the forty teams performed in the following order of events. The teams were numbered consecutively; and the odd numbered teams performed the odd numbered problems, the even numbered teams taking the even numbered problems.

1. Treat a lacerated wound of the right side of head (temple) and a lacerated wound on top of the right shoulder; one man event.
2. Treat a punctured wound over the left eye and lacerated wound of palm of right hand; one man event.
3. Treat a simple fracture of left collar-bone and simple fracture of jaw; two men event.
4. Treat a dislocated right shoulder and simple fracture of right leg; two men event.
5. Treat conditions of a man who has fallen on an electric wire back down, clothing burning; rescue, extinguish fire, treat back and upper arms; team event.
6. Treat conditions of a man who has fallen on an electric wire, face down; rescue and extinguish fire, treat chest and upper arms; team event.
7. Treat gas burns of face, neck, ears and hands; team event.
8. Treat gas burns of hands, right arm and shoulder; team event.
9. Treat a broken back and simple fracture of right fore arm; team event.
10. Treat a dislocated hip and simple fracture of collar-bone; team event.

Thirty-one of the teams were from the State of Pennsylvania; two from West Virginia; and one each from Alabama,

Illinois, Kentucky, Maryland, New Mexico, Ohio, and Washington.

The souvenir first aid boxes which were presented to each first aid team and the souvenir badges which were presented to individual members of those teams, were provided by the American National Red Cross from its general fund, and from a special contribution made by John Hays Hammond for this purpose.

The souvenir banners presented as field markers to each coal company represented, and the souvenir admission badges and programs and miscellaneous expenses were provided for by the Pittsburgh Coal Operators' Association.

The steel explosion gallery was provided by the explosives manufacturers of the United States.

At 10:40 A.M. event numbered 27 illustrated the safety in using a permissible explosive in a dusty mine.

The Forbes Field Explosion Gallery is cylindrical, 133 feet long, of an internal diameter of six feet four inches, and represents an underground tunnel or part of a coal mine. The explosive is fired into the end of the gallery, within which are 133 pounds of fine coal dust from the Pittsburgh seam, distributed uniformly throughout, and 20 pounds on a wooden bench 20 feet long near the mouth of the cannon, making a total of 153 pounds of coal dust.

A permissible explosive equal in disruptive force to one-half pound of forty per cent. nitroglycerine, tamped with one pound of dry fireclay, was fired into the gallery. No explosion of coal dust resulted.

(28) The next feature demonstrated the use of birds in exploring mines after explosions or mine fires when carbon monoxide cause a large number of fatalities. Birds are much more sensitive to the poisonous gas than men; and when they are taken into a mine by a rescue party, as soon as they show signs of distress it is a warning to the party to retreat to safety. Mr. G. A. Burrell, chemist of the Bureau of Mines, took two birds in a wire cage into a glass box containing an atmosphere with one fourth of one per cent. of carbon monoxide. After three minutes the birds were overcome; but Mr. Burrell remained in the box for eight minutes and stated he had felt no ill effects from the gas. The birds were placed

in a small glass box containing oxygen and were slowly revived.

(29) At 11 A.M. a charge of black powder, equal in disruptive force to one half pound of forty per cent. nitroglycerine, tamped with dry fireclay, was fired into the gallery containing 153 pounds bituminous coal dust. It will be observed that this charge was of the same strength and was prepared in the same manner as that in event No. 27; except that different kinds of explosives were used in the two different cases, the conditions were the same in each event. The shot of black powder produced a terrific explosion of the coal dust, as was anticipated. President Taft pressed the electric button which fired the shot and caused the explosion. This was the most spectacular event of the day. It did not equal in realism the mine explosion of the night before, but it was witnessed by a greater number of people.

(30) A rescue party of mine foremen of the Bureau of Mines, aided by squads representing the Illinois Mine Rescue Station Commission, the Reading Coal & Iron Co., and a number of local coal companies, and equipped with various types of artificial breathing apparatus, entered the gallery after the explosion and recovered three supposed victims, placing them in care of a squad of mine foremen and first aid miners of the Bureau of Mines, who demonstrated the following problems, using the pocket first aid packet and such things as may be handy at a mine after an explosion:

Problem 1. Miner overcome by after-damp and having lacerated scalp. Treated by one miner.

Problem 2. Miner slightly overcome by after-damp and suffering from simple fracture of right thigh and compound fracture of right forearm near wrist. Treated by two miners.

Problem 3. Miner overcome by after-damp and suffering from simple fracture of right collar-bone and simple fracture of left arm. Treated by two miners.

Then the Red Cross Ambulance came on the field and carried the injured miners away to the hispotal. Then a second rescue party brought out two miners and placed them

in the care of the first aid squad who by this time were provided with bandages and a full equipment of first aid supplies.

Problem 4. Miner overcome by after-damp and burned about face, neck, ears and hands. Treated by two miners.

Problem 5. Miner overcome by after-damp and burned from waist line up. Treated by three miners.

The two days program was concluded with speeches by Governor John K. Tener, Secretary of the Interior Walter L. Fisher, Miss Mabel Boardman, of the American National Red Cross, and by the President of the United States, William H. Taft, Mr. Taft presenting the trophies to the winning first aid teams.

SANITARY ENGINEERING AT HARVARD UNIVERSITY.

BY GEORGE C. WHIPPLE,

Professor of Sanitary Engineering.

The Graduate School of Applied Science at Harvard University is founded upon the basic principle that engineering, using the word in the larger sense, is one of the learned professions; that the education required of one who enters this profession should be not only scientific and technical, but broad and humanitarian. The engineer of today must not only know the underlying principles of the mechanical sciences and be conversant with the details of his special work, but if he is to become the director of great enterprises he must have the power to think logically and reach conclusions quickly, write clearly and speak forcibly—not to mention such moral qualities as honesty, enthusiasm and that vague something termed personal magnetism. Some of these qualifications are inherent in the individual, some come with experience; but the power to think and speak and write should be a matter of early training, the knowledge of scientific principles should be acquired by the maturing mind and the application of these principles made the last step in the educational process. The instruction in applied science in its utilitarian aspect should be carried only far enough to illustrate general principles and to enable the student to take up some particular line of work intelligently and with such a degree of skill that he can earn a reasonable income during the early years after graduation, when he is getting his real experience in his chosen profession.

It is partly in response to the world's demand for broad-minded engineers, and partly because science itself is becoming so broad and its branches so interwoven, that the applied sciences are being taught more and more as graduate

courses in our universities, and that the technical schools are looking forward to longer courses than the usual period of four years. The problem is everywhere the same—how to obtain a proper balance between breadth of study and specialization. That specialization has been somewhat overdone in the past seems to be the verdict of employers: on the other hand, it is equally true that in the attempt to combine various sciences relating to one vocation there has been sometimes too great a dispersion of thought and interest. Sanitary engineering is one of the fields where there is great danger that the student's energies may be spread out too thin, for this branch of engineering is one that invokes the aid of many sciences. Not only must the sanitary engineer be versed in mathematics and mechanics, but he must have a working knowledge of parts of chemistry, biology, bacteriology, microscopy, meteorology, geology, hygiene, preventive medicine, vital statistics. Unlike other branches of engineering, sanitation is concerned not alone with iron and stone and other inert building materials, but with organic matter and living things. The purification of water and sewage is due largely to biological action, and the knowledge of bacterial processes is scarcely less important to the sanitary engineer than that of the laws governing the flow of water in pipes and the strength of materials. While this is acknowledge, it is also true that, first and foremost, the sanitary engineer must be an *engineer* and the collateral sciences subordinated to the main issue. In arranging the new courses in sanitary engineering at Harvard University this idea has been dominant.

But sanitary science is becoming so important that there is room not only for the engineer but for the sanitary specialist, for the man who devotes his energies to the chemical and biological problems apart from engineering design. Men of this type are now doing useful service, but the need for such men is limited in number when compared with those required to build and operate waterworks and sewage disposal plants, lay out streets and keep them clean, ventilate

cars and buildings and otherwise apply the principles of engineering to public hygiene. Many young chemists and bacteriologists have become successful in the operation of engineering works, as, for example, water filtration plants, but it has been because they have obtained their engineering knowledge in the school of experience; on the other hand, some who have been ambitious in this direction have soon reached the limit of their ability. Such positions are best filled by men of adequate mechanical engineering training, with a knowledge of chemistry and biology sufficient to enable them to make the necessary routine analyses.

Besides the sanitary engineer and the specialist in sanitation, the world today needs—and the need is very great—a kind of man just beginning to make his appearance—the sanitary executive, or, as he is more often called, the health officer. There are already many so-called health officers serving on Boards of Health. Some of these men are great leaders, well worthy of the honorable positions they hold, but the rank and file of them are ill-fitted for their important task. Our public health machinery was installed when the hygienic wisdom of the town was wrapped up in the family doctor and when the physician was the logical custodian of the public health. With the growth of the science of bacteriology and preventive medicine and the application of engineering all this is changed. The ability to diagnose a case of smallpox and keep a record of deaths is no longer a sufficient qualification for the health officer of even a village, while the growth of our cities is continually demanding that the man in charge of the public health of so many people shall be an expert in his line.

Medical training alone does not fit men for this service. The problem of curing disease is quite different from the problem of preventing disease. The former deals with human beings as individuals; the latter considers them as units of a mass. The prevention of disease involves mathematics: statistics relating to the sick and the dead must be constantly and daily used in order to show what forces of dis-

ease are at work, and where the attack is next likely to be made. It involves engineering; for the public must be protected against impure air and infected water, streets must be cleaned and garbage removed. It involves chemistry; for the public must be protected against the sale of adulterated and poisonous foods. It involves bacteriology; for infectious diseases much be diagnosed and antitoxins provided. It involves law; for the health officer must be able not only to discern evils but to eradicate them. But the duties of a health officer should not be entirely repressive and punitive. There is a positive side. His department should be an educational force in the community, constantly instructing the people in the arts of hygiene and in the principles of right living. Many believe that this educational function of the health officer is one of the most important of his duties.

Harvard University aims to provide instruction for sanitary engineers, for those who desire to become specialists in sanitation and for those who desire to become public health officers This work is just beginning and the courses first provided and now being given are intended primarily for students of engineering and for those who are candidates for the degree of Doctor of Public Health in the medical school. Later it is planned to broaden the field.

The headquarters of the Sanitary Engineering course are in Pierce Hall, Cambridge, where, during the past summer, a laboratory was fully equipped for the analysis of water, sewage, air, filter sand, etc., and for research work in water filtration and sewage purification. A part of the latter work will be carried on in the field at various plants scattered through the state, thus putting the student in contact with actual works in operation. The instructing force includes a professor of sanitary engineering and two instructors in the laboratory, one a specialist in bacteriology, the other, in sanitary chemistry.

Two courses are offered during the present academic year. The first, catalogued as 9*A*, is a general introductory course in sanitary engineering, intended for civil engineers who do

not wish to specialize in this direction, for students of the medical school, and for other properly equipped graduate students in the University. This is a lecture and recitation course with little laboratory work. The topics to be covered are water supplies and water purification; rainfall and run-off from watersheds; storage of water; stream pollution; sewerage and sewage disposal; garbage disposal; street cleaning; disposal of trade wastes; plumbing; ventilation; public health; vital statistics; application of biology and chemistry.

The second course, catalogued as 20*Q*, is a specialized course intended primarily for engineers who intend to practice sanitary engineering. It consists of three parts. Part *A* is a course of laboratory work in the physical, chemical, microscopical and bacteriological analysis of water and sewage, air analysis, analysis of filter sand, etc. It is given during the first term and is in charge of the instructors. Part *B* is a continuation of Part *A* and is largely a research course, involving original investigations and field work in subjects connected with water purification, stream pollution, sewage purification, and the disposal of factory wastes. It is given during the second term and is in charge of the professor of sanitary engineering and the instructors. Part *C* is a course in sanitary design which will be taken up in connection with, and as a supplement to, the course in the theory and design of structures given by Professor George F. Swain. It is devoted particularly to the design and operation of waterworks, filter plants, sewerage systems and sewage disposal works. It is given during the second term and is in charge of the professor of sanitary engineering and an instructor in civil engineering. Those who wish to devote particular attention to this phase of the subject may omit the laboratory work and devote equivalent time to problems of design. On the other hand, those who wish to devote their attention specially to the laboratory work may omit the course in sanitary design. It is not expected, however, that candidates for the degree of civil engineering will do this.

No special degree is given in sanitary engineering, but the

courses above referred to are accepted as a part of the work specified for the degree of Master in Civil Engineering (M.C.E.), this being in accord with the idea advanced at the beginning, that the sanitary engineer should be essentially an engineer.

During the early years, while the number of students is comparatively small, these courses will be thrown open to qualified students not candidates for the master's degree. It is thought that engineers in practice, or those who desire to take up some particular line of research will avail themselves of this opportunity.

The Harvard University Medical School now offers courses leading to the degree of Doctor of Public Health (Dr.P.H.). Although candidates for this degree are recommended to take the medical courses by way of preparation, these are not demanded as prerequisites and arrangements will be made for specialization in sanitary engineering, sanitary chemistry, or sanitary architecture. The degree will be given after four years' work in such branches, or, in the case of medical graduates, after one year's work, provided that the last year's work in the medical school has included certain foundation studies such as advanced bacteriology, protozoology, and preventive medicine. The ability to conduct original research is considered essential for the attainment of this degree. It is the intention of the university to maintain the scholarship involved in acquiring this degree at the highest possible standard, the object being to educate men for leadership in sanitary science. Dr. M. J. Rosenau, Professor of Preventive Medicine and Hygiene, is chairman of the faculty committee on the degree of Doctor of Public Health.

For those who desire to fit themselves as health officers, it is believed that the course in sanitary engineering, supplemented with certain courses in the medical school, the law school and the university, made possible by the free elective system in vogue at Harvard will furnish an admirable training.

THE LACK OF RELATION BETWEEN MATHEMATICAL AND ENGINEERING TALENT.*

BY W. M. RIGGS,

President, and Consulting Professor of Engineering,
Clemson Agricultural College of South Carolina.

"May a student lacking in mathematical talent hope to become a successful engineer?"

It is because in nearly all the schools and colleges of the country this question is being answered, I think incorrectly, in the negative, that I wish to present the affirmative side, and even go to the extent of saying that in my judgment, mathematical talent is not only *not* indicative of engineering talent or ability, but actually indicative of an order of intellect unsuited to the practice of a profession whose outlook is as wide as the world, and as many-sided as is human effort and achievement. It is just about as fair to judge an architect by his talent in the use of the hammer and saw; a band-master by his ability to perform on a single instrument of his orchestra; a financier by his talent to add and subtract figures; a general by his distinction as a marksman; a newspaper man by his facility as a type-setter; as to judge of the latent engineering ability of a boy by his talent to make use of the tool mathematics, however useful to the engineering profession that tool may be.

Engineering is the application of educated common sense to the affairs of life. To be a civil engineer, or an electrical engineer, or a mechanical engineer, or any other kind of engineer, one must be able to perceive, to originate and to bring to pass. The civil engineer who designs a bridge across a river can employ a mathematical artisan at $3.00 per day to compute

* Abstract of a paper read before the South Carolina State Teachers Association, 1911.

the size of every member of the structure, but *he* must decide upon the best place to build the bridge to accommodate the probable growth of the city for twenty-five years to come. *His* judgment must decide how large locomotives are likely to be ten years from to-day. *He* must foresee how many people, long after he is gathered to his reward, will pass daily over the span, to which must now be dedicated millions of money and for years entrusted thousands of lives. He must even know the temper of the town council, nor fail to count upon the active opposition of every ward politician whose property is not benefited by the new crossing place. The hydraulic engineer can employ a man to calculate the dimensions of his dam, and the size of his wheels, but *his own* common sense must tell him whether his stream will block with sand; whether he can control the probable flood waters; whether he can buy at a reasonable price the riparian rights necessary to the development; whether he can sell his power in existing markets; what markets he can create; what competition he must meet and overcome. These are the larger problems that concern every engineer worthy of the name, and woe be to that man who seeks the solution of them between the covers of his calculus! For mathematics proceeds along fixed lines—with definite factors we must get a definite result. There is no palliation, no turning aside to scan the financial or the political horizon. The questions of politics and cost have no place in this well-regulated aristocracy. What has mathematics to do with judgment? It is a law unto itself; its conclusions are the children of its own logic. To give and take, to sacrifice the small point to gain the large, to smile, to palliate, to count the cost in money and time and effort—these are considerations that no formula, however complicated, has been devised to take into account.

I have been a teacher of electrical engineering for fifteen years, and during that time have graduated in my special line nearly 300 young men. I have been responsible for the first positions of over two thirds of this number, and have watched their progress with interest and critical concern. I have seen

those young men possessed of large personality and gifted with the divine qualities of common sense and sound judgment, go forward to positions of large responsibility and large opportunity, while the bright boy (said to be bright because he would work quickly his mathematical problems and English exercises) becomes a "hewer of wood and drawer of water," and spends his days over the slide rule and the drawing board, reducing to figures the ideas of other men—doing the drudgery of some *big* man who has forgotten almost all he ever knew about mathematics, although the *training* he derived from this study is still one of his valuable assets.

I would not see our college mathematics reduced in character or amount. We need all we have to accomplish the great educational work it does for our students. I wish if anything, we could give to it *more* time in order to teach that homely but most important and only ultimately applicable form of mathematics—arithmetic. For no matter how long and winding the route by which our formulas or results are obtained, in the end they must be applied to the affairs of life in terms of two and two make four, and three times three make nine. But before we can bring ourselves to have arithmetic taught in a college course, we must shake off a pride rooted in conservatism and nurtured, I fear, by an ambition to get upon the Carnegie foundation, and ask ourselves the question, and answer it honestly, how much of humbug is there in our college curriculums, and how far do we propose to be bound by the methods and traditions of a past, as different from present conditions as is the great white way of the city different from a narrow street illuminated only by the lantern of Diogenes?

I would not underrate mathematics as a "mind-trainer." It need not even seek refuge in that time-honored phrase (which has covered a multitude of sins), as so many of the subjects which pedagogic conservatism retains in our curriculums need to do. I would not deny to it a deserved place in the galaxy of subjects thought necessary to collegiate respectability. I would not rob it of a single tradition, or a real use, that clusters about its hoary head, but, I do decry the

mistake of discouraging a boy from the pursuit of an engineering education, and denying to him the possibility of a successful engineering career, because he *finds it hard* to prove that the squares on the hypotenuse is equal to the sum of the squares of the other two sides; and that two parallel lines meet at infinity.

Let him *struggle* in the mathematical gymnasium as much as necessary. It may be *hard* for him to "skin the cat" of algebra and "chin the pole" of calculus, but *make him do it.* He will be all the better and stronger for it. But because he is *slow* to attain strength, because he sees things mathematical "as through a glass darkly," do not say to him "My boy, let not your inclinations turn you to the path of an engineer," or "Young man, take the agricultural course or the course of law, or the literary course, you can never be an engineer because you have no mathematical talent, *mathematics comes too hard to you.*"

Mathematics is a means to an end, not an end in itself, and useful though it is, it is not the criterion by which to measure talent along other lines. A knowledge of what can be done with the saw is valuable to the architect; a knowledge of how long it takes to add and subtract figures is no doubt valuable to the financier; the study of mathematics is a splendid training, and proficiency in it *is a valuable asset,* but after all, the mark of genius in any line is not the ability to use tools, but the ability to originate ideas, to make plans, to accomplish results, and if there is one profession more than another that calls for these powers it is the engineering profession.

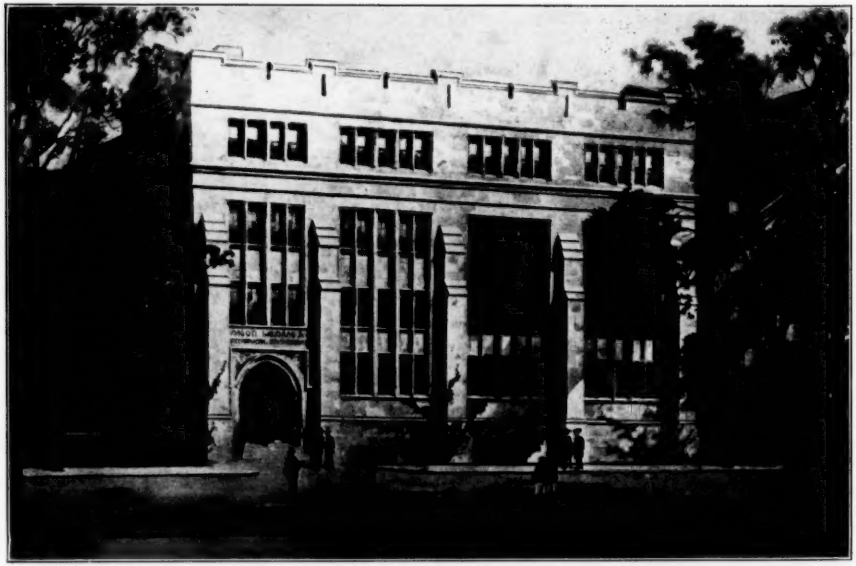
THE MASON LABORATORY OF MECHANICAL ENGINEERING FOR THE SHEFFIELD SCIENTIFIC SCHOOL OF YALE UNIVERSITY.

BY L. P. BRECKENRIDGE,

Professor of Mechanical Engineering.

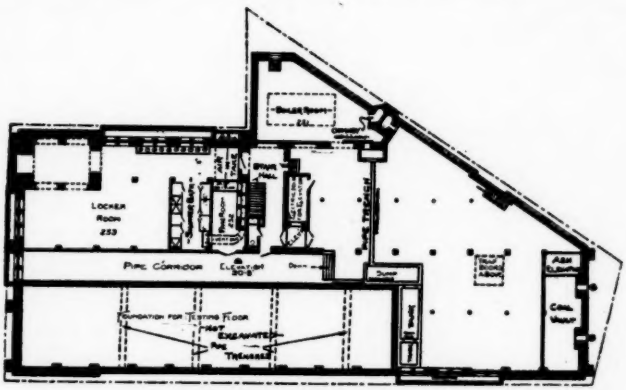
The new Mason Laboratory of Mechanical Engineering is now completed and the department of mechanical enginering has transferred its headquarters to the new building. The building is the gift of two brothers, Mr. William Smith Mason, of Evanston, Illinois, and Mr. George Grant Mason, of New York City, both of the Class of 1888. The gift includes two hundred thousand dollars for building and equipment and fifty thousand dollars for endowment. Mr. Charles C. Haight, of New York City, was the architect, and C. P. Stuart & Co., were the general contractors.

The laboratory is located on the east side of Hillhouse Avenue between Grove and Trumbull Streets, on land purchased some time ago by the Sheffield trustees. The frontage on Hillhouse Avenue is 85 feet and the building extends through to Temple Street, a length of about two hundred feet. The architect has worked out a very pleasing design. as the cut represented shows. The long windows at the right are at the end of the testing floor, above which is a clear head room of thirty-five feet; at the left the smaller windows indicate the location of the main gallery and the mezzanine floors, which are possible on this side of the building throughout the greater part of its length. The building has three stories above the basement. The front rectangle is of Indiana limestone harmonizing with the Leet Oliver building opposite. The extension back to Temple Street is of brick with suitable trimmings of stone. The entrance from Temple Street is sufficiently large for the admission of a



THE MASON LABORATORY OF MECHANICAL ENGINEERING FOR THE SHEFFIELD SCIENTIFIC SCHOOL OF YALE UNIVERSITY (see p. 252).

team, so that heavy pieces of machinery are delivered directly under the electric travelling crane, which extends the entire length of the building (two hundred feet) with a span of forty feet. This crane is of 10 tons capacity. The floor plans indicate the general distribution of equipment and the arrangement of rooms for offices, lectures, research, and general experimental work. No provision for recitation or drawing rooms has been made—the entire building being devoted to



BASEMENT PLAN

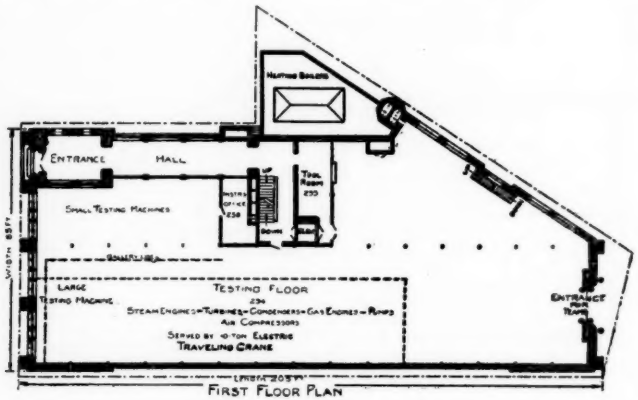
instruction in experimental work for undergraduates and for research work in engineering science for graduate students, research fellows, and special investigators.

The main floor contains the larger part of the equipment, especially the heavy machinery such as the machines for testing the strength of materials, steam engines and gas engines of various types, steam turbines, steam and centrifugal pumps, and air compressors, together with the auxiliary equipment of condensers, fans, electric motors, scales, tanks and smaller appliances for testing.

This equipment is directly under the crane. The units are, for the most part, small and self-contained. A large part of the floor under the crane is of heavy concrete suitably

arranged with parallel grooves for bolting the equipment at any point. The steam, water, gas, and other pipes are run in the basement below, provision being made for their extension to the testing floor through a series of auxiliary tunnels which occur at frequent intervals. All testing floor areas are suitably drained so that an abundance of water may be used whenever desired.

In the front basement is located the toilet and locker room. There are several shower baths. The boiler room

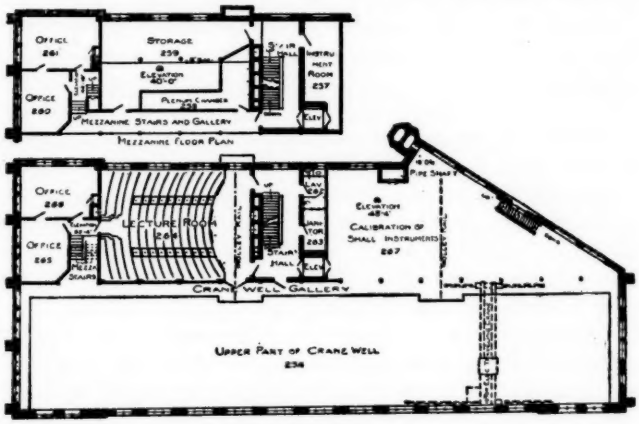


FIRST FLOOR PLAN

extension provides for the heating and power boilers. An auxiliary power plant, both steam and gas electric, will be located near the boiler room. Tanks of concrete provide water storage, and a large sump below the level of the street drain receives all drainage not otherwise provided for. The sump is automatically emptied by a centrifugal pump electrically driven. Coal storage bins and ash elevating machinery is located at the Temple Street end of the building. Access to the basement is provided for heavy machinery through a large trap door suitably located under the crane, as well as by an electric elevator which connects all floors.

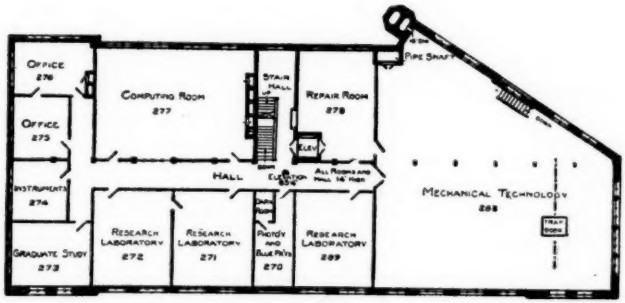
The gallery floor contains considerable space available for

lighter machinery, several small offices, and the general lecture room, with a seating capacity of one hundred and seventy. There are two landing platforms on this floor so that



SECOND FLOOR PLAN

the large crane may deliver heavy pieces under a trolley rail extending through the lecture room or across the open floor space at the east end of the laboratory.



THIRD FLOOR PLAN

The distribution of space on the third floor is evident from an inspection of the plan of that floor.

The room devoted to mechanical technology will be used as a laboratory for instruction in machine design, machine construction, and mechanism. It is planned to have on exhibition modern machines of special and complex design. Power will be available for the operation of such machines as are placed here for study. This laboratory will not contain shops for students. Illustrative material representing manufacturing processes or special devices of interest to the students in mechanical engineering will be arranged for study in this room. A trap door, located directly over the lower entrance driveway, furnishes an easy access for bulky pieces, a trolley rail being located directly above this opening. It will be noted that the electric passenger elevator (6 feet by 6 feet) is located so as to serve all hallways on one side and all instruments, stock and repair rooms on the other.

The completion of this laboratory gives to the Sheffield Scientific School many needed facilities available for all its engineering departments and gives to mechanical engineering what the Hammond Laboratory gives to the students of mining engineering.

RESULTS OF EXPERIENCE IN TEACHING SCIENTIFIC SHOP MANAGEMENT.*

BY HUGO DIEMER,

Professor of Industrial Engineering, Pennsylvania State College.

The subject of this paper is one in which I have been interested and along lines in which I have been working in the educational field for nearly ten years. At the 1903 meeting of this society, I presented a paper on "Education for Factory Management,"† in which I advocated the teaching of shop time study and factory economics along the lines indicated in the present paper by Professors Hibbard and Philbrick. At the 1907 meeting I advocated a more liberal recognition of the field of industrial engineering by advocating the establishment of courses in industrial engineering.‡ A tentative course in industrial engineering was described in the *Engineering Magazine* in June, 1908.§ This course was briefly described in the paper presented before this society, on "Employers' Requirements of Technical Graduates" by the writer in 1907.‖

I am convinced that the correct way to take recognition of the problems referred to is to recognize Mr. Charles B. Going's definition of industrial engineering, as given in his recent book entitled "Principles of Industrial Engineering." His definition is as follows:

"Industrial Engineering is the formulated science of management. It directs the efficient conduct of manufacturing, construction, transportation, or even commercial enterprises and any undertaking, indeed, in

* Presented as a part of the discussion of the paper by Professors Hibbard and Philbrick.

† *Proceedings*, Vol. XI, page 151.

‡ Volume XV, page 110.

§ Vol. XXXV, No. 3, page 349.

‖ Vol. XVII, page 172.

which human labor is directed for accomplishing any kind of work. Industrial engineering has drawn upon mechanical engineering, upon economics, sociology, psychology, philosophy and accountancy, to fuse from these older sciences a distinct body of science of its own. It does not consist merely in running the power plant or machinery nor merely in devising processes or methods. In consists in coördinating all these things and others, in the direction of the work of operatives and using the equipment provided by the engineer, machinery builder, accountant and architect.

"The industrial engineer may have in his organization staff many mechanical engineers superintending special departments—design or construction, or the power plant, for instance—while his own duty is to coördinate all these factors and many more, for the one great, central purpose of efficiency and economical production. The work of the industrial engineer not only covers technical counsel and superintendence of the technical elements of large enterprises, but extends also over the management of men and the definition and direction of policies in fields that the financial or commercial man has always considered exclusively his own.

"Industrial engineering deals with machinery; but not so much with its design, construction, or abstract economy, which are strictly mechanical considerations, as with selection, arrangement, installation, operation and maintenance, and the influence which each of these points or all of them together may exert upon the total cost of the product which that machinery turns out. It deals with materials, but not so much with their mechanical and physical constants, which are strictly technical considerations, as with their proper selection, their standardization, their custody, transportation and manipulation. It deals very largely with methods; but the methods with which it is particularly concerned are methods of performing work; methods of securing high efficiency in the output of machinery and of men; methods of handling materials, and establishing the exact connection between each unit handled and the cost of handling; methods of keeping track of work in progress and visualizing the result so that the manager of the works may have a controlling view of everything that is going on; methods of recording times and costs so that the efficiency of the performance may be compared with known standards; methods of detecting causes of low efficiency or poor economy and applying the necessary remedies. It deals with management—that is, with the executive and administrative direction of the whole dynamic organization, including machinery, equipment and men. It deals with men themselves and with the influences which stimulate their ambition, enlist their coöperation and insure their most effective work. It deals with markets, with the economic principles or laws affecting them and the mode of creating, enlarging, or controlling them."

I have quoted thus at length from Mr. Going's book in order that there may be a distinct understanding that we who are championing the cause of industrial engineering have no desire to weaken courses in mechanical engineering nor to supplant such courses.

There is no question but that machine shop work, as given in college shops, is capable of great improvement. At the Pennsylvania State College we have carried on a course in machine shop time study for the past three years. I attach to this paper a set of data sheets indicating to what extent the work has become standardized with us as a result of these three years of experience. While I share the enthusiasm of Messrs. Hibbard and Philbrick for everlasting emphasis on principles, I wish to emphasize the fact that a man who would attempt to be an efficiency engineer, depending on principles alone and without experience in methods, would be just as inevitable a failure as the half-baked efficiency engineer to whom the authors refer, who mistakes systems and methods for the fundamental science.

By way of illustrating another portion of our methods, I have attached also a copy of the routing or instruction sheet used in our machine shop, with the simplest exercise in the lathe, consisting of the turning and facing of a small cast iron cylinder. The beginners in machine shop work are not given the time elements which go with the various steps designated in the instruction card. The establishing of time elements is left to the students taking the time study course, who make comparison of their results with figures obtained through the courtesy of a large manufacturing company, who supplied us with the time and other machine data which would be specified for the pieces if they were being run through their shop. We also conduct a planning department and "Daily order of work" board in our machine shop.

The point I wish to emphasize particularly, however, is that if we want to carry out Messrs. Hibbard and Philbrick's policy of teaching fundamental principles instead of teaching merely methods, we must recognize industrial engineer-

ing as a distinct field and recognize that it demands men of a different temperament than mechanical engineering and that these men must be given an entirely different college course.

The four years' course in industrial engineering, as given at the Pennsylvania State College, prepares the student desiring to enter industrial organizations in positions leading to superintendence, purchasing, selling, scientific management and corporation officerships. It aims particularly to prepare for the bettering of industrial efficiency. It prepares the graduate for the competent handling of such subjects as departmental management in factories, determination of costs, depreciation, manufacturing statistics, proper distribution of expense, economic production, systems of remunerating labor and raising labor efficiency, the handling and recording of stores, stock, and orders, sales, purchasing, planning of production and production methods, corporation accounting, and allied work, leading ultimately to superintendence, works management and general management.

For the purposes indicated well-trained engineers are required; hence the course includes all the fundamental engineering work in mathematics, drawing, physics, chemistry, machine design, heat engineering, mechanics, hydraulics, and structures that are common to all other engineering courses of the School of Engineering. But more time should be and is given to such general studies as industrial economics, logic, and psychology, also to specialized work in accounting, factory management, shop time study, machine tools and methods, factory planning, and more shop practice in general than is offered in other engineering courses. The study of logic, psychology and economics is intended to give the student the underlying foundations for acquiring ability to get along with men as a shop executive, a salesman, purchasing agent or business manager, and to arrange and plan his work logically and systematically. The large amount of shop-work and shop methods, corporation accounting, cost accounting and factory economics, will give him a grasp of

these matters which should be of material value in manufacturing processes.

The course offered is in line with replies received from many manufacturers to a canvass of them to get their opinion as to what studies best train for their industries.

Following are a few of the printed forms illustrating some of our methods in connection with the application of the principles of scientific management in our machine shop, namely Tool List, Instruction Card, and Time Study Notes.

My object in exhibiting these examples of what we have done and what we are doing is to present helpful suggestions to others planning to undertake this work and to elicit further suggestions from others along the same line.

TOOL LIST FOR	OPERATION Turn and Face

MACHINE No.....DRAW. Nos.....501.....

PIECES	NAME	SIZE	TOOL SYMBOL
	Exercise must be centered with drill and countersink on speed lathe equipped for this purpose.		
1	Carrier	2¼″	
1	Round nose	PP	PRR
1	Side		PUBC
1	Side		PUSG
1	File	12	

The above tool list is handed each student together with the detailed instruction list covering movements and methods, the tools being provided in a box, ready to use, for each individual.

The Pennsylvania State College. Industrial Engineering Department.

INSTRUCTION CARD FOR OPERATION.

SHEETS, SHEET No.		DRAWING No.	MACHINE No.	ORDER No.	
MATERIAL	CLASS No.	PIECES			

DESCRIPTION OF OPERATION

ITEM	DETAILED INSTRUCTIONS	FEED	SPEED	Element Time per Piece	Time for Entire Lot	Continuous or Running Time
1						
2						
3						
	Full size of sheet 8½ by 12½ inches.					
38						
		MONTH	DAY	YEAR	SIGNED _____ CHECKED	

LIST OF OPERATIONS APPEARING IN COLUMN OF DETAILED INSTRUCRIONS FOR THE OPERATION OF LAYING OUT AND DRILLING CENTERS.

(1) Change card. (2) Learn what is to be done. (3) Remove fins or roughness from piece on emery wheel. (4) Grind scale from ends before centering. (7) Put piece in vise and clamp. (8) Chalk one end. (9) Find center of one end with hermaphrodites. (10) Punch where marked with center punch. (11) Turn piece end for end in vise and clamp. (12) Repeat items 7 to 10 for other end. (13) Take piece to speed lathe. (14) Put centering drill in chuck. (15) Put one center punch mark in tail stock center. (16) Bring the other center punch mark to drill. (17) Start machine. (18) Drill hole 3/8″ deep. (19) Repeat items 15 to 18 for other end. (20) Stop machine. (21) Remove drill, put in 60° countersink. (22) Change speed (slower). (23) Put one drilled hole on center in tail stock. (24) Bring other hole to countersink. (25) Start machine. (26) Countersink hole to 5/16″ dia. (27) Back piece from countersink. (28) Repeat items 23 to 27 for other end. (29) Take piece from machine and clean, put tools in proper place. (30) Take piece to your assigned machine. (31) Set machine and see that centers are true. (32) Put carrier on one end of piece and tighten. (33) Clean centers in both ends of piece. (34) Put piece in machine and oil tail stock center. (35) Adjust machine and put in backgears. (36) Put PUBC or PUSC in tool post. (37) Adjust tool and tighten same, tool to set 15° to the left. (38) Start machine.

LIST OF OPERATIONS FOR TURNING AND FACING.

(1) Face end, remove all scale with first cut. (2) Finish facing with 2d cut, take 3d cut if necessary. (3) Stop machine. (4) Reverse piece, put carrier on other end. (5) Put piece in machine oil, center on tail stock end. (6) Start machine. (7) Repeat items 1 to 3 for other end. (8) Make length of piece exact size on print. (9) Stop machine and measure. (10) Remove tool, put in PRR. (11) Set tool about 15° to left and tighten same. (12) Start machine. (13) Move tool to the piece at tail stock end. (14) Rough turn piece to within ½″ of carrier and make 2 3/32″ dia. (15) Stop machine. (16) Reverse piece, put carrier on other end. (17) Put piece in machine, oil center on tail stock end. (18) Start machine. (19) Rough turn balance of piece to 2 3/32″ dia. (20) Stop machine, see if tool is sharp. (21) If sharp finish turn to within ½″ of carrier. (22) Stop machine. (23) Reverse piece, put band of copper on finished end, clamp carrier on same. (24) Put piece in machine. (25) Start machine. (26) Finish turn balance of piece to 2 1/16″ dia. (27) Stop machine gauge and measure. (28) Clean machine. (29) Remove carrier from piece and put on rack. (30) Clean piece and stamp your number on same.

Note:—Place piece together with instruction cards, print templates and gauges on desk in the office.

We have extended the principle of detailed instruction sheet and motion study to the forge shop also. The following list is taken from the instruction sheet for standard exercise No. 1. The department is working out similar sheets for instruction in wood shop operation and foundry exercises. By the close of the present year we hope to have all of our present series of shop exercises standardized.

LIST OF OPERATIONS FOR HEATING AND BENDING WROUGHT IRON (3 INCH RING).

(1) Clean all clinkers and ashes off tuyere. (2) See that tuyere holes are clean. (3) Try blast (see that it is free). (4) Place 3″ wood pin on tuyere. (5) Pack green coal tightly around pin. (6) Draw pin out. (7) Put shavings or oily waste on tuyere. (8) Light shavings or oily waste. (9) Turn on small amount of blast. (10) Put crushed coke on lighted shavings. (11) Turn on more blast. (12) Put more coke on fire. (13) Get stock (1 pc. ¼″ rd. 10¼ in. long). (14) Put stock in fire. (15) Heat stock yellow heat 1″ from end. (16) Remove stock from fire with flat tongs. (17) Square up end of stock with hammer. (18) Reverse stock and place it in fire. (19) Heat stock to yellow heat. (20) Remove stock from fire with flat tongs. (21) Repeat operation 17. (22) Place stock in fire. (23) Heat stock to red heat 2/3 length of stock. (24) Remove stock from fire with flat tongs. (25) Bend stock half-way round horn of anvil. (26) Reverse stock and place in fire with flat tongs. (27) Heat to red heat. (28) Remove stock from fire (flat tongs). (29) Bend straight end around horn of anvil. (30) Complete exercise on horn of anvil or mandril. (31) Have piece inspected. (32) Fill out work card and tie to exercise. (33) Put finished exercise in box for finished work. (34) Return this instruction card and blue print to proper place. (35) Get instruction in card and blue print No. 2. (36) Read same carefully.

The detailed instruction sheets showing minutely all motions and methods, are furnished with the blue-prints of the exercises during the first half of each semester's shop course. Our experience has been that the student finishes these pieces under this system in about two-thirds of the time formerly taken, without the system. During the second half semester each student works without the tool list and instruction sheet, and in addition to performing the exercise, prepares a tool list and detailed instruction sheet himself, which is then cor-

rected by the instructor. The Time Study work is given only to those taking the Industrial Engineering Course. The following notes will indicate the nature of this work:

TIME STUDY NOTES.

Read over carefully before beginning work.

1. Make sure that there is at hand all of the following equipment before beginning work: watch, stop-watch, cutmeter, speedometer, balances, or scales, set of weights, calipers, 12-inch scale, and materials for recording.

2. Begin to take time when operator starts to get stock, and keep accurate record of every second until piece is finally completed. All time must be accounted for.

3. While operator is getting stock, prepare scales for weighing and have instruments at hand for measuring. Insert sketch of piece in rough in the proper place.

4. Before starting to machine the piece, both operator and observer must carefully examine machine, see that centers are in line, become familiar with each handle, knob or lever connected to the machine, together with the different actions of the machine when any one of these are adjusted. After this, the operator will oil the machine wherever there is a cup or hole for same.

5. After roughing cut has begun, take cut meter and speedometer readings and record; then sketch and measure cutting tools not then in use. In this manner, keep abreast of the operator in order that an accurate and full record of all procedure may be had. Don't forget to weigh after each operation.

6. The observations on each separate experiment must be computed and recorded, presented to the instructor in charge, and receive his approval before the next experiment in the series is begun. Be sure that you have the time per cubic inch and per lb. for each operation completely figured on one piece before going to work on another piece. A copy of the correct computation must be kept on the back of the recording sheets as a check upon errors.

INSTRUCTIONS TO OPERATOR.

1. The observer as well as the operator must use extreme care in making time studies, to see that the proper sequence of operation is maintained, and all unnecessary operations or moves are eliminated. Also that the most economical combinations of speed, feed and cut are used, as well as the most suitable tool for each operation. If at any time, the observer is in doubt as to the correctness of time on an operation, the

operator on request of the observer, will repeat any or all operations desired.

2. Do not start for stock until observer has everything in readiness for the experiment.

3. Do not fail to keep observer fully informed of every detail of procedure, so that a perfect record of the experiment may be made. The operator can help materially in this.

4. Do not fail to weigh the piece after each metal-removing operation and have the observer record the weight.

5. See note 6 above.

Time observations to be taken in minutes and decimals of a minute.

Weight observations to be taken in lbs. and decimals of a lb.

Measurements to be taken in inches and decimals of an inch.

The weight of a cubic inch of cast iron is .2604 lb. (Kent).

The weight of a cubic inch of steel is .2833 (Kent).

The values of seconds in the decimal of a minute are as follows:

Sec.	Min.	Sec.	Min.	Sec.	Min.	Sec.	Min.	Sec.	Min.	Sec.	Min.
1	.017	11	.185	21	.350	31	.517	41	.683	51	.850
2	.033	12	.200	22	.367	32	.533	42	.700	52	.867
3	.050	13	.217	23	.383	33	.550	43	.717	53	.883
4	.067	14	.233	24	.400	34	.567	44	.733	54	.900
5	.083	15	.250	25	.417	35	.583	45	.750	55	.917
6	.100	16	.267	26	.433	36	.600	46	.767	56	.933
7	.117	17	.383	27	.450	37	.617	47	.783	57	.950
8	.133	18	.300	28	.467	38	.633	48	.800	58	.967
9	.150	19	.317	29	.483	39	.650	49	.817	59	.983
10	.167	20	.333	30	.500	40	.686	50	.833	60	1.000

FORMULAS FOR COMPUTATION.

Given: K = weight per cu. in. of material.
T = time elapsed at a given operation.
A = weight of metal removed at the given operation.
I = time per cu. in. of metal removed.
P = time per pound of metal removed.

Then

$$I = KT/A$$

and

$$P = T/A.$$

If it is impossible to secure decimal weights in avoirdupois, weigh the piece by metric weight and convert to lbs. by the following:

$$1 \text{ kg.} = 1{,}000 \text{ g.} = 2.20462 \text{ lbs. avoir. (Kent).}$$

This will give accurate weight.

1. Std. roughing and finishing tools to be used.

2. Roughing cut or cuts to be deep as possible.

3. Speed of spindle to be fast as possible.

4. Feed of carriage to be fast as possible.

Note.—Nos. 2 to 4 must be found by trial, and are satisfactory only if the roughing tool is ready for re-sharpening at the completion of the exercise. Care must be taken that the speed of the spindle is not too fast, for in this case the temper of the tool will be drawn (tool burned) making it impossible to use again before forging and tempering.

5. Slower spindle speeds and faster feeds for roughing work should be used.

6. Faster spindle speed and slower feed for finishing work should be used.

7. Exercises must be permanently centered and countersunk.

8. All gates and fins must be ground or chipped from castings before centering.

9. When turning work, cut must be sufficiently deep to remove all scale.

10. Both ends of the piece must be faced before starting to turn.

11. When facing work never allow stub end of center to remain, face completely across ends of work.

12. Always rough the entire piece before starting to finish it.

14. Allow 1/32″ for finish on cast iron and 1/64″ for finish on steel.

15. Before clamping dog or carrier on finished piece of work, put band of copper around the work to prevent marking or dents.

16. Never lay lathe tools or file on lathe shears.

17. When filing work, see that no parts of machine are in motion except lathe spindle.

18. For filing steel, run spindle at highest speed, also for polishing same.

19. For filing cast iron, run somewhat slower than for steel; for polishing, run on same speed as for polishing steel.

20. Always clean file with stick or brush, never rub hand on file.

21. When filing, never touch work with your hand.

22. Always take measurements from one end of work only.

23. Use cut meter for surface speed.

24. Use speedometer for spindle speeds.

25. Use stop watch for each operation.

TIME STUDY DATA.

Exercise No..... Machine No.....
Date Started.....Date Finished.....Time Req'd.....
Observer.....Box No.....Group Letter.....
Operator.....
Wt. Rough.....Wt. Finished.....Wt. Removed.....

(General Data)

Sketch of Rough Piece: Sketch of Finished Piece:

Note.—Fill in the space below the condition of each tool, after each operation; also the reason for the condition the tool is in.

If changes were made from original tool list, give reasons for it. If tools had to be re-ground or retempered, record here.

Further remarks:

Operation. Steps.	Surface Speed.	Spindle Speed.	Feed.	Depth of Cut.	Weight Piece.	Time.		
						Start.	Finished.	Elapsed.
1								
2								
3								
etc.								

Exercise..... Group Letter..... Machine No.....

Extra blank sheets covering individual operation data are furnished, the student being encouraged to get too many rather than not enough operation data. The individual data are then collected into a summary, as below:

Summary: Group Letter.....

Give a list in proper order of all operations in which metal was removed, stating whether emery grinding, roughing, finishing, facing, boring, thread cutting, drilling, planing, and a total of time for all like operations, etc.

Actual time spent in *removing metal only* to be listed separately:

	Time.	
	Hours.	Minutes.
Grouped Operation No.....		
1.		
2.		
3, etc., to.....		
10.		
Time getting material.....		
Time weighing.....		
Time getting tools.....		
Time grinding tools.....		
Time setting up.....		
Time spent in other operations		
Total time (should check with Sheet 1).....		

Group Letter.....

Weight of material per cu. in. .....
Total weight of material removed .....
Cubic inches of material removed .....
Give total time for all like operations .....
Give total weight .....

Operation No.	Total Time Removing Metal by This Operation.	Total Wt. after This Operation.	Total Wt. Removed by this Operation.	Time per Cubic Inch.	Time per Pound.
1.					
2.					
3.					
Etc.					

Time of getting ready per cu. in.....per lb.....
Time of tool grinding per cu. in.....per lb.....
Time of active metal removed per cu. in.....per lb.....
All other time .....per cu. in.....per lb.....
Total time .....per cu. in.....per lb.....

COLLEGE NEWS.

Carnegie Technical Schools.—New faculty appointments in the School of Applied Science for 1911–12 are: Charles B. Stanton, assistant professor of railroad engineering; Clyde T. Griswold, assistant professor of mining engineering; Clinton J. Davisson, instructor in physics; Arden B. Holcomb, instructor in electrical engineering; Joseph H. Cannon, instructor in electrical engineering; H. J. MacIntire, instructor in mechanical engineering, O. T. Gleckler, instructor in mathematics; and J. A. Fitzgerald, instructor in commercial practice and statistics.—Dean C. B. Connelley of the School of Applied Industries has been appointed one of 15 members of the new Pittsburgh Board of Public Education which, under the new school code of the State, assumed control of the educational system of the city on November 13.—Professor Horace R. Thayer, of the department of civil engineering, has made a report for the schools on the faulty construction of the Austin dam, after a personal investigation at the scene of the disaster.—Ground has been broken for a new $800,000 building for the School of Applied Design which will house the departments of architecture, interior decoration, painting, illustration, and other art courses.—Director Arthur A. Hamerschlag is a member of the new city planning commission of Pittsburgh, recently appointed by the Mayor.—The School of Applied Science offers for 1912–13 a new night course in commercial engineering. The intent of the course is to furnish training for the business side of engineering practice; therefore, only graduates of engineering schools will be eligible for admission. A four-year day course in the same subject is being offered this year for the first time.—Professor Allan H. Willet (Brown '86) has been appointed Head of the Department of Commercial Engineering.—Dr. J. C. Schaeffer, of the chemical engineering department, has resigned to become consulting expert for the Picher Lead Co., of St. Louis.—The annual catalogue, now in press, will show a registration for 1911–12 of 2,410 students.

University of Illinois.—Dr. C. P. Steinmetz recently delivered two lectures before the engineering students on "Unexplored Fields in Engineering" and "The Nature of Electrical Energy."—All of the woodworking machinery of the shops has been equipped with safety devices. The object of the equipment is not only to safeguard the students and employees, but also to furnish an exhibit of the most improved forms of such safety devices. Several of the safety devices have been designed and built in the shops.—Mr. Bruce W. Benedict, for several years in the

motive power department of the Atchison, Topeka & Santa Fe Railway, has been appointed director of the shop laboratories in the Department of Mechanical Engineering.—Among the valuable lectures delivered by non-resident speakers were the following: A series on Vocational Education in Germany by Dr. E. G. Cooley, who as a representative of the Commercial Club of Chicago has recently visited Germany and has made an exhaustive study of conditions of vocational education in that country. One by Mr. R. J. Young, of the North Chicago works of the Illinois Steel Company, a member of the Committee on Safety Devices of the United States Steel Corporation. He described a large number of devices for protecting workmen against accident in steel mills.

Oberlin College.—Science states that "the budget of Oberlin College for the ensuing year contains a special appropriation to be used in defraying the expenses of administrative officers, professors and associate professors who wish to attend meetings of educational and scientific societies."

Ohio Northern University.—In the Engineering College the total enrollment this year exceeds that of last year (378) by about 25 per cent. —Professor Jesse Beer, of the Department of Physics and Chemistry, is spending a year's leave of absence at Chicago University. His place is being filled by Professor F. L. Berges, who was formerly an instructor in the same department.—Plans and specifications for two new buildings, to be erected on the University farm, are being prepared in the Department of Civil Engineering. One of these buildings is to house the agricultural laboratory, the other the dairy equipment and a ten-ton refrigerating plant.

Imperial Pei Yang University (Tientsin, China).—The Imperial Pei Yang University is now nearly bankrupt, due to stoppage of funds, and the faculty does not know what will happen. At present all the faculty but one are staying at the University and trying to carry on the work. Out of 140 students only 15 to 20 are left and these do not attend classes. For form's sake our President (Chinese) has requested us to attend classes, and so we attend each class for 10 minutes, sign the roll and depart. The reason for this is that it is easier to start up a university in China that is nearly dead than one that is quite dead. In many ways we are more fortunate than many of the other universities in China. There have been no disturbances in Tientsin except financial ones and all the university property is still intact. The valuable articles have been removed and stored in the American Consulate for safe keeping. In central China university work has been suspended and in many cases the universities have been looted and burnt. In addition many of the students have been beheaded by the government forces. All members of

the faculty are very sorry to have the rebellion at such a time, as the Pei Yang University had just started on the brightest year of its existence with over 70 new students and these well equipped for their work. It may be interesting to know what becomes of the foreign staff in a time like this. Different universities have different forms of contract. Ours provides for one month's salary and return passage, but there is no money at the present time to give us and we will have to wait until a stable government is formed. As stated above we are staying although we do not expect any money at present. Some of the foreign staffs in some of the universities have no provision for a case like this and I do not know what they will do.

Pennsylvania College (*Gettysburg, Pa.*).—Richard S. Kirby, C.E. (Yale '96), formerly a practicing engineer at Port Chester, N. Y., and from 1906 till 1909 instructor in civil and sanitary engineering in the Sheffield Scientific School of Yale University, has been recently appointed to the newly established professorship of civil engineering.

Pennsylvania State College.—The Pennsylvania Railroad has loaned to the College, for an indefinite period, their 28,000 lb. dynamometer car. This car will be used for instruction in the course in Railroad Mechanical Engineering and for investigations in train resistance.

University of Pittsburgh.—The first of a series of public lectures dealing with the questions of sanitation was given by Professor Wm. T. Sedgwick, of the Massachusetts Institute of Technology, in Memorial Hall, Wednesday evening, November 22. His subject was "Sanitation and its Relation to Public Health." This was the first of a series of lectures to be given by prominent sanitarians under the auspices of the School of Engineering of the University of Pittsburgh. Among the men who have addressed the students of the School of Engineering this term may be mentioned: Mr. P. M. Lincoln, consulting engineer for the Westinghouse Electric and Manufacturing Co.; Col. Thos. P. Roberts, Government Engineer in Pittsburgh; Emil B. Guenther, Mechanical Engineer with the Westinghouse Machine Co., etc.—Mr. Morris Knowles, head of the Department of Sanitary Engineering, has been retained by the Coal Dealers' Association of Alabama to investigate the sanitary conditions of its different camps.—The department of Industrial Chemical Research, under the direction of Professor Robert Kennedy Duncan, began work in September with 20 men working along different lines of industrial research. A temporary building, divided into individual laboratories, has been erected for this purpose. A small laboratory has recently been completed to study smoke prevention.

Purdue University.—By the appointment of Professor H. C. Peffer as professor of chemical engineering at Purdue University, this department

has been raised to the status of a school, coördinate with those of civil, electrical, and mechanical engineering, and made independent of the department of chemistry, which, however, will continue to give the instruction to these students in general, analytical and organic chemistry. Professor Peffer will during the current year give instruction to seniors in industrial organic chemistry and metallurgy, and direct the preparation of graduation theses. Professor Peffer is a graduate (B.S. 1895, M.S. 1907) of Pennsylvania State College and has been connected as chemist or superintendent with the Carnegie Steel Co., the Pennsylvania Salt Co., and the Pittsburgh Reduction Co., now the Aluminum Co. of America.—Mr. J. H. Cannon, instructor in mathematics, resigned this year and has taken up instructional work in electrical engineering with the Carnegie Technical School at Pittsburgh.—Dr. E. G. Bill (Acadia, Yale) and Mr. R. W. Burgess (Brown) have been appointed instructors in mathematics. Mr. Burgess was for two years Rhodes scholar at Oxford.—Professors L. D. Rowell and A. D. DuBois have joined the electrical staff, coming from Case and Cornell, respectively.—The so-called engineering assemblies which are held every Monday afternoon at four o'clock offer an opportunity for hearing outside speakers on subjects a little removed from those handled in the class room. Professor W. A. Scott, Director of the Department of Commerce at the University of Wisconsin, recently gave a spirited address before the Assembly on "A Decade of High Finance." The speaker traced briefly the various financial epochs in this country's history leading up to the decade from 1897 to 1907, and called attention to the enormous centralizing tendency of this period and the aggregation of industrial, commercial and financial interests in the two groups on Wall Street. The address was terse and comprehensive, and made a great impression on the audience.—Dr. Samuel M. Crothers, the essayist, recently lectured in the Purdue Course on "The American Temperament." His witty characterizations and his gentle satire kept the audience in a ripple of amusement.—A shop for the repair and construction of laboratory apparatus has just been equipped and put in operation. Work of this sort for the engineering schools and the department of physics will thus be concentrated at this point at a decided economy of time, space and labor. It is no longer convenient or desirable to do work of this character in the university shops, which should be kept largely if not wholly for educational work.

Pratt Institute, Brooklyn.—The new assistant instructors are: R. S. Schealer (Lehigh, '09), electricity; S. S. Rathbun (Cornell, A.B., '09, M.E., '11), electricity; R. L. Lafferander (Lehigh, '10), chemistry; D. A. Isenberg (Penn. State, '10), physics; H. C. Beltz (Alfred), physics; R. A. Whiting (Stevens, '08), mechanical laboratory; Geo. Boyd, carpentry; L. A. Gluckler, machine work.—After careful study a special

committee of the National Association of Tanners offered to coöperate with the Institute in establishing courses in tanning. Their proposition was accepted and two courses are now in operation. One is a trade course in tanning intended for men already engaged in the industry; the other is a technical course in tanning and leather chemistry, designed for graduate chemists who desire to specialize in this line. The new courses appear to have met a real need.

Throop Polytechnic Institute.—A friend of the Institute who believes in the educative value of travel has established two scholarship awards to be known as the Senior and Freshmen Scholarship Prizes, respectively. The Senior Scholarship Prize, consisting in ample provision for a trip to Europe, is awarded on each commencement day to that member of the graduating class who has the best record in scholarship for the Junior and Senior years, the Faculty taking also into account, in assigning the award, considerations of deportment, or good manners, and ability for original work. No award shall be made, however, unless the Faculty shall adjudge some member of the graduating class to be sufficiently distinguished in scholarship to justify it. This prize is $750 cash. The Freshman Scholarship Prize, consisting in full provision for a journey through some of the principal cities of the eastern United States, over a route recommended by the Faculty, is awarded on each commencement day to that member of the Freshman class who has the best scholarship record for the year, good manners and the quality of initiative being also taken into account. This prize is $250 cash. No award shall be assigned in case the Faculty deem the record insufficient to justify it. The Faculty may, in some instances, permit this prize to be used for other purposes than travel, but reserve the right to indicate the mode of its use in case of any such exception.

Union College.—About one year ago Union College established a course of study leading to the degree of Doctor of Philosophy. The major subject of the course is to be chosen from the field of electrical science. Two minor subjects must be followed, one of which is to be philosophy. The work is to be done in residence under the personal direction of Dr. Charles P. Steinmetz. Several candidates have enrolled, choosing for their second minors, history, English literature, chemistry and mechanical engineering. Among the subjects already given for research and preparation of theses in connection with the major subject are electric arcs, corona, transient phenomena upon long-distance transmission lines, wireless telegraphy and transient phenomena in mutually inductive circuits.

Washington University.—The completed registration in all departments shows a total enrollment of 1,377, a gain of 30 per cent. over last year.

The increase in the Schools of Engineering and Architecture is approximately 10 per cent.—In the Department of Electrical Engineering, preparations are under way for the continuation of previous investigations concerning the fatigue of insulation. The results thus far secured have opened up a new series of studies, which will be taken up independently of the original study.—Professor Charles Abella, who was appointed Professor of Design in the School of Architecture, beginning in September of the present year, has been achieving remarkable success in his new work. Professor Abella came to St. Louis from Paris, where he distinguished himself by securing the First Second Grand Prix de Rome and by winning at various times, in competitions at the Ecole des Beaux Arts, seven Medals and two First Medals.—At the same time Mr. Lawrence Hill was appointed Instructor in Architecture.—Among the newly elected officers of the Engineers' Club of St. Louis there are the following members of the faculty of Washington University: Professor A. S. Langsdorf, President; Professor E. L. Ohle, Director; and Professor E. O. Sweetser, Librarian.—Mr. Robert S. Brookings, President of the Corporation of the University, recently gave the sum of $250,000, to be applied to the endowment fund.—On Friday evening, December 8, 1911, Professor George F. Swain, of Harvard University, addressed a joint meeting of the Washington University Association and the Washington University Chapter of Sigma Xi, on "Forestry and Stream Flow Problems." On Saturday afternoon, December 9, he addressed the members of Sigma Xi, on "The Quebec Bridge and its Fall."

Williamson Free School of Mechanical Trades.—A recent circular states that the average wages of members of the class which graduated in March, 1910, was $16.60 per week six months after graduation; while on September 1, 1911, the average wage of the 1911 class was $15.57, notwithstanding the depression in business.

Yale University.—In the Department of Mechanical Engineering Mr. Charles J. Porter has been recently appointed as instructor. The number of students in this department has increased rapidly during the past three years.—In the Department of Civil Engineering Mr. R. H. Suttie has been added to the staff of instructors. The program for studies in this department has undergone extensive changes during the past year, among the most important of which are the following: The course in mineralogy has been made optional, and the course in the adjustment of observations has been moved from the senior year to the first graduate year. A course in steam engineering and a seminary course have been added to the courses of the junior year. The courses in surveying are now given during seven weeks of the summer vacations.—In the Department of Mining and Metallurgy Mr. Luther W. Bahney has been appointed assistant professor of metallury. Professor Bahney has occu-

pied a similar position at Leland Stanford Jr. University for the past three years and before that was connected with the Selby Smelting and Lead Company in California.—Dr. C. H. Mathewson has been promoted from the position of instructor in metallurgy to that of assistant professor of metallurgy.—Arthur F. Taggart, E.M., has been appointed instructor or in mining engineering beginning January 1, 1912. Mr. Taggart is at present engaged in field work in the southwest.—Recently a new course has been established in the department leading to the degree of metallurgical engineer. This course requires a total of five years' study. The first three—or undergraduate—years are devoted to a thorough training in mathematics, chemistry, physics, mineralogy, geology, etc., and the fundamental engineering subjects. Students who satisfactorily complete the first three years are granted the degree of Ph.B. The remaining two years are devoted to the study of metallurgy and the various branches of mechanical, electrical and civil engineering which are necessary to the practicing metallurgical engineer. General courses in mining and detailed courses in ore dressing and economic geology are also taken by the student during these two years. During the summer preceding the fifth year students are required to spend three months in study and work at a metallurgical plant. It is planned to have the student carry on laboratory investigations of the processes observed during the summer months and to make the data gathered in this way the basis of a graduation thesis.